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Age and Growth in Fishes

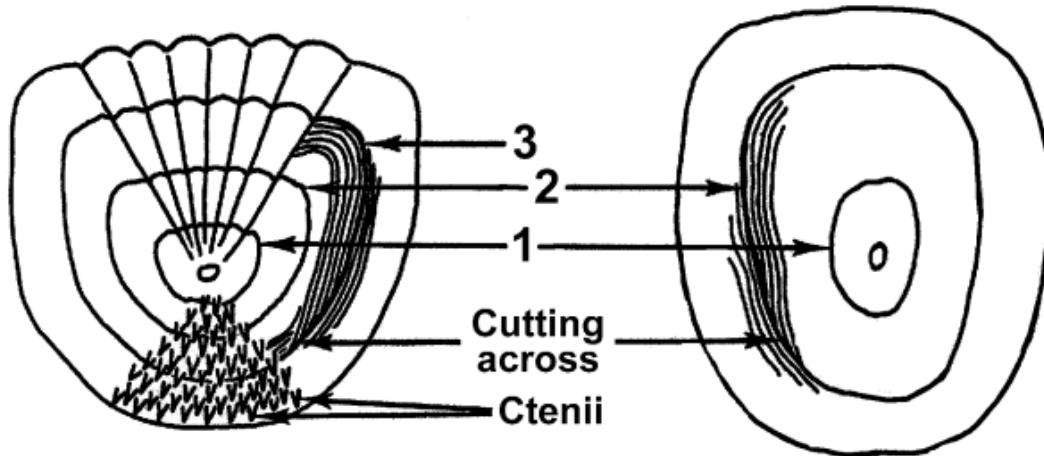


Figure 9.1—Ctenoid scale of bluegill (left) and cycloid scale of sucker (right). Annuli are indicated by numerals.

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- Growth is one of the basic characteristics of living organisms and which primarily **increase in body size as a function of age.**
- It involves increment in size and enhancement of weight.
- In aquaculture, where juvenile fishes of known age are reared, growth rate is easily determined with period of culture.
- In natural water bodies, age and growth studies are essential to understand the age structure of a population from which mortality rate is estimated.
- The annual variations in fish catch rely upon growth pattern of the stock of a species.
- It is often desirable to segregate the fish catch on the basis of age groups to understand the vulnerability of any specific age group to the fishing gear.



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Growth in fishes can be determined by counting annual or daily rings that are formed on hard parts such as scales, otolith, vertebrae etc.

The annular rings are formed due to seasonal variations in temperature and availability of food in the environment.

Another direct method of recording growth is by tagging and recapture, but it is expensive and recovery of tagged fishes is meager.

In the case of crustaceans, the only hard part is shell or exoskeleton which is shed periodically.

So, direct estimation of age and growth is not possible in crustaceans.

However, several indirect methods have been developed which allow the conversion of length-frequency data into age composition.



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Growth model

One of the integral elements of the dynamics of fish population is growth.

It can be expressed by mathematical models which are employed to estimate size of a fish at given age.

Mathematical expression of growth is necessary for integrating it with the analytical models which are used for management of exploited fish stocks.

The most widely used model for growth is given by

Von Bertalanffy (1938).



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Growth model

- The von Bertalanffy growth function (VBGF) is expressed as:

$$L_t = L_\infty (1 - e^{-K(t - t_0)})$$

- Where, 'L_t' is length ant age t
- 'L_∞' is the maximum size that could be attained by a fish; it is also termed as **asymptotic length**.
- 'K' is a **growth coefficient** at which fish attains the maximum length and
- 't₀' is a **hypothetical age** at which **length of a fish is zero** and 't' is time to reach the length L_t.
- These parameters of growth are integrated in dynamic pool models to know the optimum size of a fish that can be harvested on sustainable basis.



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Methods of Age Determination using Hard Parts



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Age determination using hard parts of fish

Fishes grow continuously, but growth rate varies over time and season and also depending on the characteristics of the habitat they live. Hard parts like bones, spine, otoliths, scales etc. also increase in size with the fish.

Hard part grows by deposition of different minerals in a biological matrix. Any changes in growth rates may be reflected as zones or bands in the hard parts.

By tracking down these inscriptions age of the fishes can be determined.

During slow growth phase rings/bands will be laid close together, whereas during fast growth phase they will be laid far apart.

Among skeletal structures, otoliths and scales are most widely used as they are easy to collect and store.

The opercular bones of the head, pectoral and pelvic girdles dorsal spine etc. were also widely used.



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Scales

For age and growth study, 3-4 scales from the region between dorsal fin and lateral line are removed.

They are cleaned after removing extraneous matter and mucous by washing in tap water and rubbing between finger tips.

To make scales more clear and soft,

they are dipped in weak solution (1%) of KOH for about 5-10 minutes, then washed in tap water and dried in air and preserved as dry mounts.

Small sized scales are mounted between two glass slides and studied with the help of compound microscope or stereoscopic binoculars at appropriate magnification through the eye piece fitted with oculometer.



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Lateral scale radius and the distance between the focus and annuli are measured for a relationship between scale radius and fish length.

By extrapolating the regression line, a correction factor is calculated and the value so obtained is used for back calculations and the growth parameter

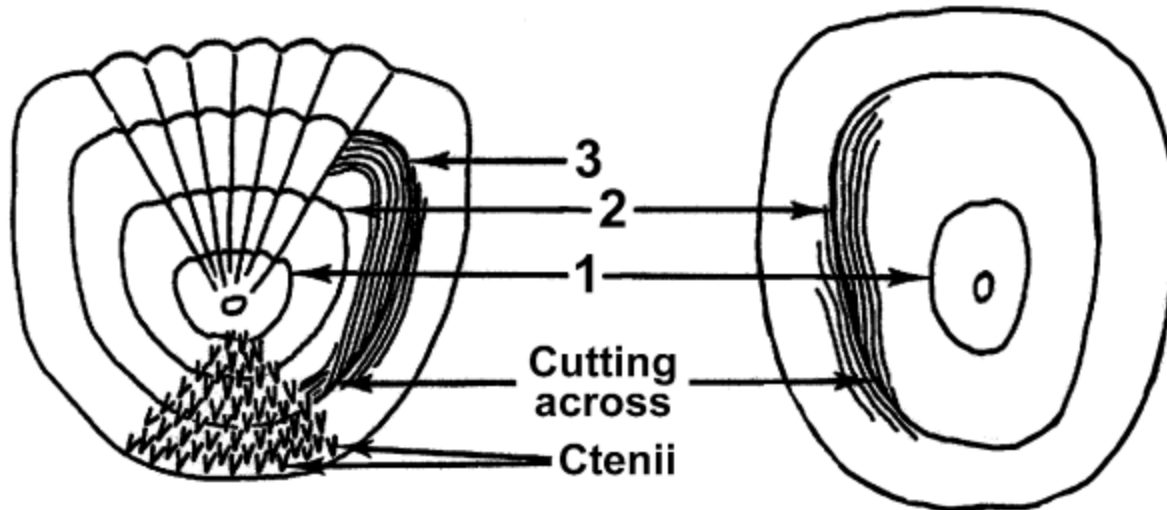


Figure 9.1—Ctenoid scale of bluegill (left) and cycloid scale of sucker (right). Annuli are indicated by numerals.



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Number of Annuli on the Scale	Estimated Age	Designation of Age Group
None	Less than one year old	0+
One	One year old	1
One + a few circuli	More than one year old but less than two years old	1+
Two	Two years old	2
Two + a few circuli	More than two years old, but less than three years old	2+



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Opercular bones

It is easy to collect the opercular bones of the commercial fishes from the processing industries or fish markets.

The opercula should be detached from the skull and freed from extraneous muscles.

These bones should be boiled in water for about ten minutes and all muscles may be cleaned with a soft brush for 4-5 minutes.

The annual rings become clear with storage.

Using black background, the opercular bones are observed under stereo-binocular microscope.



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Due to large size, it is difficult to measure the opercular length and the annuli either under binocular microscope.

Under such conditions, the rings on the bone are marked and traced with pencil.

The opercular length O-A,
the annuli O-A1, O-A2, O-A3,....O-An are measured and regression analysis of opercular length and fish length is carried out.

The regression equation is used for back-calculations.



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Vertebrae

The vertebrae lying below the dorsal fin (if two fins are present, then below the first dorsal) are removed and cleaned by boiling in water for 10-20 minutes to remove muscles.

Then they are soaked for several minutes in detergent, rinsed in tap water and dried at 35° C.

They can be stained with alizarin Red S, rinsed and air dried.

There are two methods for examining the annual layers.



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1. The central point of a vertebra is examined under a stereoscopic binocular microscope.
2. The vertebra is cleaved length-wise in the dorso-ventral direction; half of the vertebra is fixed on wax so that the flat side is directed upwards and examined under stereo-binocular microscope.



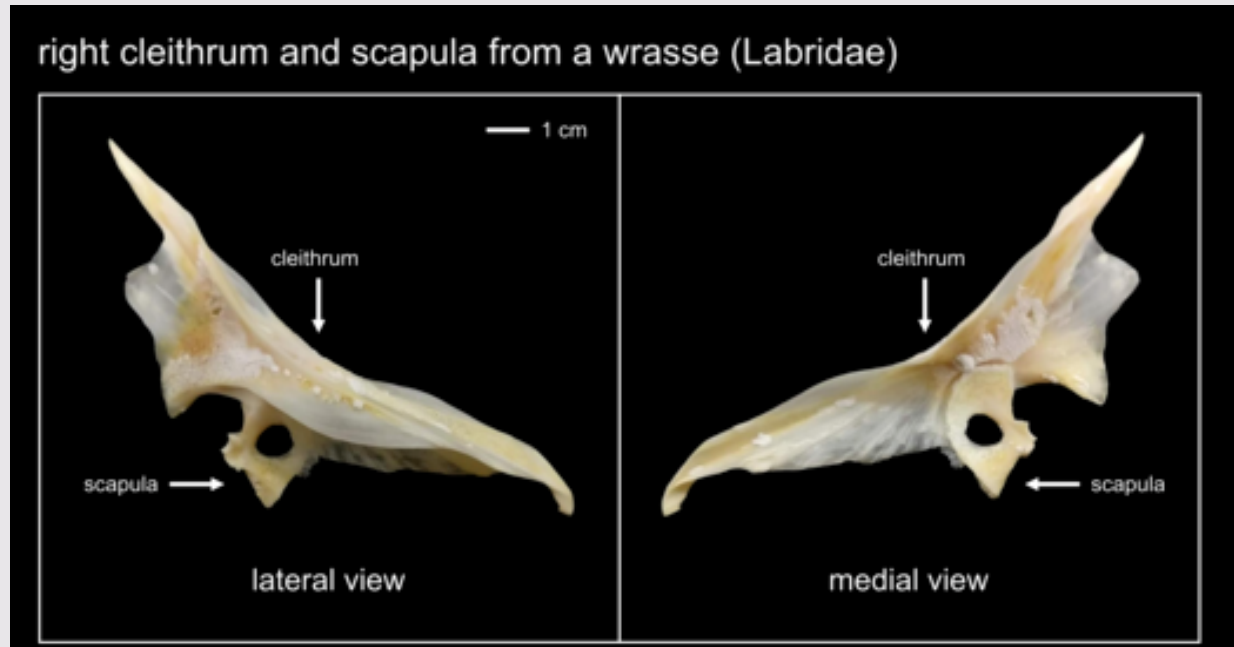
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Frontal bones

Growth rings are observed under reflected polarized light against dark back ground.

Cleithra

These can be viewed under stereoscopic binocular microscope.





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Otoliths

Sagitta, Lapillus and Asteriscus are the three otolith present in the membranous labyrinth of fish on each side.

Of these, sagitta is the largest and often used in age determination.

They are located in the sacculus of the inner ear.

The otoliths exhibit the best pattern of growth as calcium resorption is not known in them.

Their use has been found satisfactory in young and fast growing fishes.

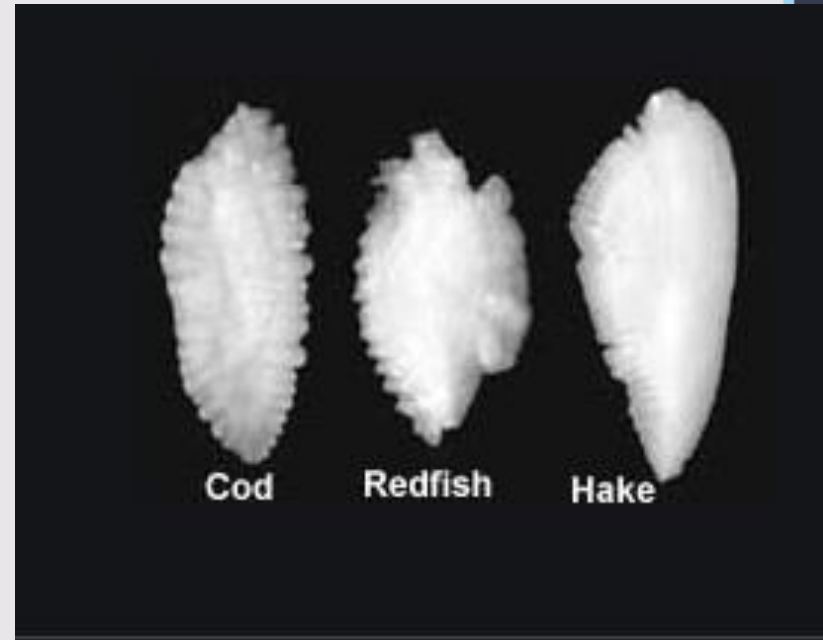


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Otoliths removed from the membranous labyrinth can be stored in glycerol and water in the ratio of 1:1 with a little thymol added to the solution to prevent growth of bacteria and fungus.

It has been reported that otoliths stored upto 5 years show no loss of clarity.





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Length frequency method

In length frequency method or size frequency method,

the **basic principle** is that the length frequency distributions tend to group themselves around a central value called **mode**

and the progression of modes through successive intervals of time (*e.g.* month) indicates the pattern of growth.



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Collection and processing of length frequency data

1. Samples for length frequency should be collected at random from the commercial catches as soon as they are landed.
2. Sampling should be done before sorting into various market size groups.
3. Length data should be collected separately for different gears and for different mesh types of the same gear.
4. Length frequency data are to be recorded twice or thrice in a week from the landing centre.
5. While collecting the length data, sexes should be treated separately.



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6. It is better to take the length frequency data for a period of two years (24 months).
7. Individual lengths are grouped into appropriate size classes which should not normally exceed twenty five.
8. The weekly data may be pooled on a monthly basis.
9. The data thus pooled must be drawn in the form of frequency polygons or histograms for each month.
10. Progression of modes is traced through



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Petersen method

This is a single sample method and is very simple, fastest but most inaccurate method of ageing fishes.

This method can be used only with species which have a restricted spawning season so that the fish bred in a single season can be identified as a single mode in a polymodal length distribution.

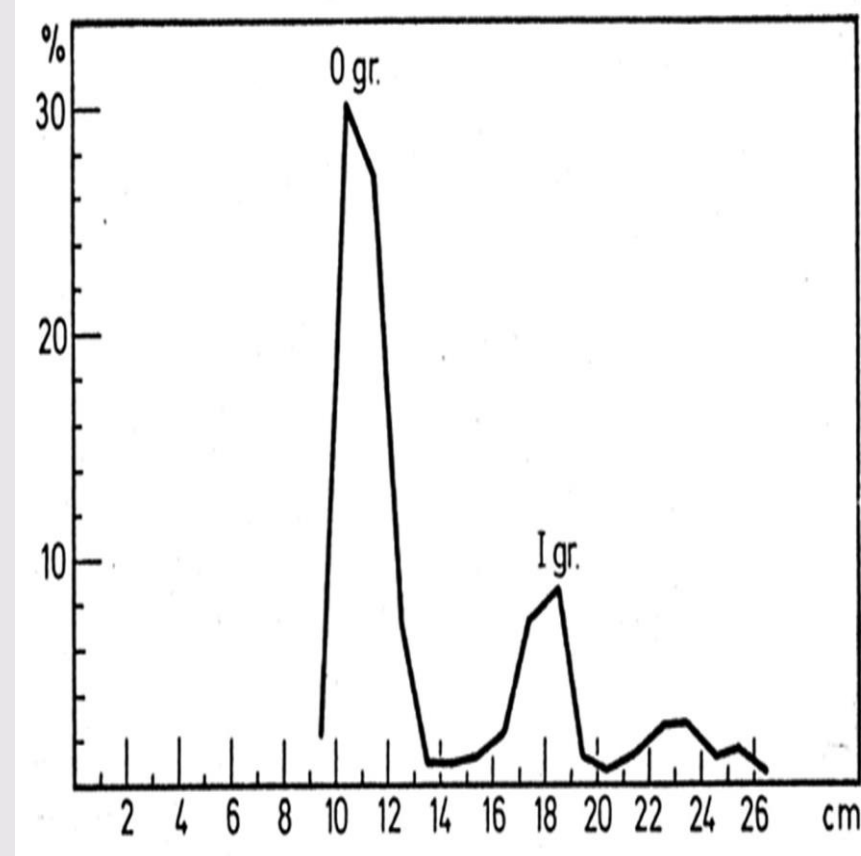
The mode with the lowest value is identified as 0-year group fish. Subsequent modes will be 1-year group, 2-year group fish and so on



The method can be very good for young fish but becomes increasingly less useful for older fish as the growth rate slows down and the modes merge.

In practice length frequency distributions of fish caught over the shortest time period possible are plotted; the shorter the time period the more precisely the modes will be defined.

A regular sequence of such length frequency distributions enables the progression of the modes to be followed.





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